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Lifelong Learning of Applied Statistics: The Need, The Potential and The Perspective

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The Need

Technology of World Wide Web (WWW) and Internet brought tremendous changes in our lives in general, as well as in the realms of education, how we learn and cognize, the way we communicate the knowledge and train on skills [1]. In the Age of Information technology-based teaching and learning methods, approaches and tools became the major means of developing competences in all areas of education, including (applied) statistics [2]. Having EU developmental strategies and priorities as a starting point and basic environment for overall educational development, the lifelong learning concept and strategy creates one of the key underpinning features of the set of crucial initiatives aimed in preparing citizens and professionals for their role in society and the economy [3-5]. In such setting the field of applied statistics has the evident importance, not only within the broad field of mathematics, as one of a few essential axes of research, development and innovation, but as one of the crucial supporting knowledge areas for achieving EU developmental objectives and priorities as a whole [6-8].

The Age of Information produced, in some sense, the World of Data and consequently established Data Science, as "*a discipline that incorporates varying degrees of Data Engineering, Scientific Method, Math, Statistics, Advanced Computing, Visualization, Hacker mindset, and Domain Expertise*" aimed at "*solving complex data analysis problems*" [9, 21]. Adopting mathematics of (applied) statistics as a discipline and method for the quantitative study of phenomena makes evident that, together with ICT, it is the one of the essential enablers of data science. Collecting, classifying, extracting, analyzing and using data significantly affect and rules many processes and activities, ranging from everyday life to scientific achievements to strategic political, economical and industrial decisions. To meet the underlying challenges higher education policy involves engagement of lifelong learning principles to provide educational framework for professional and personal development of knowledge, skills and understanding of a statistics. This policy addresses variety of subjects related to natural, technical, engineering, health and social sciences [10-11]. Its main goal is to provide and improve statistical literacy, in particular for the professions other than mathematics. Conforming European strategies and priorities, higher education policy in Republic of Serbia emphasizes and promotes contemporary trends in lifelong learning, here presented in the field of applied statistics.

University of Kragujevac (Serbia) is located in an industrial, educational and political region with bright tradition in labor and community relationships. The courses or modules of Applied Statistics are taught at a several Faculties, such as Faculty of Engineering, Faculty of Technical Sciences, Faculty of Medical Sciences and Faculty of Economics, in addition to the courses of Mathematical Statistics at Faculty of Science. However, at most cases the topics covered include only the basic principles, lacking more advanced, robust and rigorous methods required for coping with data sets analysis in modern industrial, economical, health, educational and societal

environment. In that course, the initiative expressed through Tempus project "Master Program in Applied Statistics – MAS" aims at developing and implementing a master curriculum in applied statistics and to organize a lifelong learning program in applied statistics for professionals in different fields. Fulfillment of this important goal meets the clearly identified labor market and professional requirements.

The Potential

"*Statistical literacy is portrayed as the ability to interpret, critically evaluate, and communicate about statistical information and messages*" [16]. This more than decade "old" explanation and description of statistical literacy came upon thorough survey and study of the reports published during 1990's, clearly asserts and emphasizes the importance and strength of the discipline as a whole. It also promotes the importance of statistical thinking among population for their proper engagements with trends and phenomena of social and personal importance, such as crime rates, population growth, spread of diseases, industrial and agricultural production, educational achievement, or employment trends [11, 16]. Apparently, statistical literacy more or less concerns and affects all ages of population, all professions, and society in general. Therefore, an adequate study and training programs may provide overall improvement in better understanding, perception, and trust of the different statistical data and illustrations, daily presented in media, reports, workplaces, and schools.

Lifelong learning program in applied statistics aims at education of statisticians and training of other professionals (engineers, economists, medical doctors, teachers/educators, etc.) to build their own specific competences that enable and support their personal, labor market, and professional interests. In the region of Central Serbia, where University of Kragujevac is located, the following interest groups are identified:

- **Professional statisticians** – this group implies those people that have graduated from Master Program in Applied Statistics, earned PhD degrees; their main occupation is to further develop capacities in the field and train human resources, in addition to quantitative and qualitative research and innovation activities [17-18]; University of Kragujevac offers experts from Faculty of Mathematics and Natural Sciences, Faculty of Economy, Faculty of Engineering Sciences, Faculty of Technical Sciences and Faculty of Medical Sciences;
- **Teachers** (elementary and high school) – the most of the teachers in elementary and high schools have not experienced work in the area of applied statistics, although their almost daily duties require dealing with qualitative and quantitative indices of teaching progress and education achievements; on the other side, in the technology empowered era their role more than ever impacts basic statistical literacy that inevitably should be communicated to the pupils and students to prepare them for understanding and engagements with statistical data common in modern societies [19-20];
- **Researchers** – University of Kragujevac is renowned higher education institution and engaged in numerous national and international research projects; it is needless to mention and elaborate the crucial importance of deep knowledge, understanding, and learn from research data; involvement of applied statistics professionals (experts) in almost every research team arise as the inevitable need;
- **Medical and Health professionals** – having Clinical Centre Kragujevac as the regional medical and health institution involved in numerous clinical trials, observational studies, radiological and imaging processes, physiological and pathological screening and treatment, becomes quite natural that dedicated statisticians are already engaged [15]; however, the tremendous breakthroughs and

progress in the area of medicine and health sciences alerts for permanent advancements and improvements of the capacities in the long term;

- **Public services** – transportation and urban planning, investments, business and finance trends are just a few of a numerous underlying areas of public services where decision making and policy creation heavily depends on statistical data expertise, thinking and mindset [22-25];
- **Regional and Municipal Governments** – Municipality of Kragujevac is the regional centre and serves for surrounding and neighboring communities as the pool for information processing, such as local government and public expenditures, monitoring of crime rate and security, waste management, sustainable development; having that the most important task of official statistics is to provide a realistic picture of social and economic developments in the municipality, the region and the country, as well as to provide a reliable basis for decision making at various levels of government and other institutions, across the businesses, to interested citizens, permanent demand for statisticians and ICT professionals to support technology enhanced handling and mining of such information and data is quite evident [22-25];
- **Industry** – (foreign) investments in Serbia and the region of Central Serbia are growing; creating underpinning policy and supporting strategies are not feasible without comprehensive analyses and dedicated teams to data science that are capable to handle problems posed by data and generate sustainable new ideas extracted from available variety of economical, technical, financial, demographic, educational, and societal data sets; "Fiat Serbia" and satellite cooperating companies (suppliers) are just an fully illustrative example to justify empowering technology enhanced field of applied statistics [26-27].

Recognizing the need and importance of (applied) statistics of the Republic of Serbia, the European Union has already invested heavily in harmonizing our statistical system to EU statistical system and the changes that occur in the transition process [28-29]. Additionally, all legal acts and strategic documents in Serbia and the region of Municipality of Kragujevac (including University of Kragujevac) directly or indirectly emphasized the need to further develop the field of applied statistics. One of main objectives is to achieve better fundamental and technological support, as well as to improve statistical literacy of the population, which is in coherence with other Government of Serbia Strategies and Action Plans. The set of priorities in this direction is elaborated through national developmental strategies [28]. These concerns all segments of our society: Economy and Finance, Infrastructure (ICT, energy, transport), Agriculture, Forestry, Environment, Employment, Social Affairs and Health, Education and Science, Youth and Sports, Public administration, Judiciary, Human rights, Defense and foreign policy.

The Perspective

Tempus project "Development of Lifelong Learning Framework in Serbia" (JP 145010-2008, http://www.delfis.kg.ac.rs/), coordinated by University of Kragujevac, was one of the first to widely promote the concept and strategy of lifelong learning. Its key objectives are (a) development of high-quality lifelong learning system supported by ICT, (b) development of national system for recognition and valuation of LLL, and (c) promoting entrepreneurial culture in education and training and cooperation with enterprises. Despite the main orientation towards entrepreneurship programs, project outcomes clearly underlines, among others, market analysis and dealing with corresponding statistics. "Master Program in Applied Statistics – MAS" appears as the reinforcement of the already undertaken efforts in providing national support for continual preparation of the working force for modern societal and industrial challenges. Understanding that applied statistics has a lot to do with inter- and multidisciplinary disciplines, together with other

fundamental principles, approaches, methodologies, and technologies, it is interlaced and converging in numerous distinct application domains [12]. Furthermore, it demonstrates strategic importance to research, innovation and progress pathways. As University of Kragujevac initiated another Tempus project "Studies in Bioengineering and Medical Informatics - BioEMIS" (http://www.birmingham.ac.uk/research/activity/BioEMIS/index.aspx), which identified Biomedical Statistics as the course within first 30% of significance, after thorough analysis of related study programs at 221 European universities [13-14]. Applied Statistics in biomedical and health sciences obviously represents a fundamental scientific component dealing with and resolving problems of epidemiology, clinical trials, observational studies, physiology, imaging, and genomics, to mention a few fields [15]. Finally, University of Kragujevac participate to Tempus project "Interdisciplinary Curricula in Computing to Meet Labor Market Needs - **INCOMING**" (http://htk.tlu.ee/incoming/), as well. The objective is to develop interdisciplinary study program in Information Technology for E-Business. Again, applied statistics is one of the fundamental courses within the study program.

In this way spreading courses of Applied Statistics over several study programs that educate professionals of different orientations proves sustainability at university level. On the other side, considering development of lifelong learning of Applied Statistics in society at large, faculty members and teaching staff participating in the Tempus project "Master Program in Applied Statistics – MAS" already developed a series of dedicated technology-enhanced courses for teachers and professionals in local government, health services, and researchers that intensively use ICT and worldwide known statistical software, such as SPSS, Statistica, MatLab (Statistics Toolbox), and Excel. The response and number of attendees to already organized courses provides sound estimates of feasibility and sustainability at a long run.

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